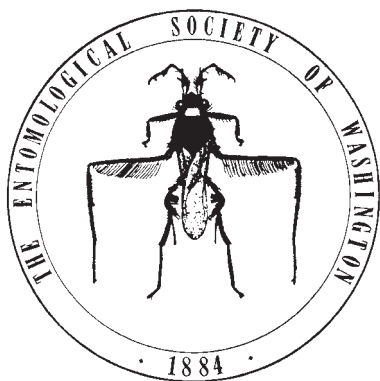


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ENTOMOLOGICAL SOCIETY
of **WASHINGTON**



***ANTHOCORIS CONFUSUS* COLLECTED FROM WESTERN WASHINGTON
STATE, WITH A SUMMARY OF NORTH AMERICAN RECORDS
(HEMIPTERA: HETEROPTERA: ANTHOCORIDAE)**

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Abstract.—The predatory true bug *Anthocoris confusus* Reuter is native to Europe and Asia. Scattered records for this species in North America date from 1929. In 2007–2008, we collected adults and nymphs of *A. confusus* from deciduous trees in western Washington State. This is the second North American record for *A. confusus* from west of the Rocky Mountains, and is the first record from the western United States. Specimens were collected from European beech (*Fagus sylvatica*; Fagaceae) and linden (*Tilia* sp.; Tiliaceae). The linden trees were heavily infested with the aphid *Eucallipterus tiliae*. The presence of adult and immature bugs, and the occurrence of the species at the collecting site in consecutive years, suggests that *A. confusus* is established at this location. We summarize North American records for *A. confusus*, briefly discuss host plant records, and list traits used to separate *A. confusus* from other *Anthocoris* spp. Additional predatory Heteroptera collected from linden and European beech included three other Old World species, *Anthocoris nemoralis* (Anthocoridae), *Campyloneura virgula* (Miridae), and *Orthotylus nassatus* (Miridae), as well as one native species, *Deraeocoris fasciolus* (Miridae); the record for *O. nassatus* is the first for this species from western North America.

Key Words: introduced species, true bugs, *Fagus*, *Tilia*, *Anthocoris nemoralis*, *Campyloneura virgula*, *Orthotylus nassatus*, *Deraeocoris fasciolus*

Species of Anthocoridae (Hemiptera: Heteroptera) are important natural enemies in agricultural and natural habitats throughout the world (Lattin 1999). *Anthocoris confusus* Reuter (Reuter 1884) is a widespread species of the Palearctic Region found throughout western Europe, east into Siberia and Asia (including China, Mongolia, and Japan), and south into Tunisia, Iran, and Israel (Hiura 1959; Péricart 1972, 1996; Elov 1976; Péricart and Halperin 1989). It is one of the more common species of

Anthocoris in certain habitats of western Europe (Southwood and Leston 1959; Anderson 1962; Hill 1965, 1978). This predator occurs often on deciduous trees, but can be found also on herbaceous plants (Hill 1965).

There are scattered records for *A. confusus* in North America dating back to 1929. It is unclear how or when the species was first introduced into North America. The only published record for *A. confusus* in western North America is for a specimen collected more than 30 years ago in British Columbia (Scudder 1986). We collected adults and nymphs

* Accepted by Michael W. Gates

Table 1. Location of collection, month and year of record, number of specimens, and literature citation for *Anthocoris confusus* collected in North America.

Location	Month and Year of Record	Number of Specimens	Reference
Ontario, Canada	1929, 1930, 1939, 1943, 1950, 1955, 1958, 1961, 1962	multiple	Anderson and Kelton (1963), Kelton (1978)
Tannersville, Greene Co., New York	September 1932	1	Scudder and Foottit (2006)
Bar Harbor, Hancock Co., Maine	May 1938	1	Procter (1946)
Isabella County, Michigan	October 1938	multiple	Kelton (1978)
Roan Mountain, Carter Co., Tennessee	September 1955	3 ♀, 5 ♂	Lewis et al. (2005)
Grandfather Mountain, Avery Co., North Carolina	August 1957	(not stated)	Anderson and Kelton (1963), Kelton (1978)
Joanna Bald, Graham Co., North Carolina	October 1957	1 ♂	N.C.S.U. museum
Mars Hill, Madison Co., North Carolina	September 1959	1 ♀	N.C.S.U. museum
Kentville, Nova Scotia, Canada	July 1995	2 ♀, 1 ♂	N.C.S.U. museum
Prince Edward Island, Canada	July 1966	apparently multiple	Kelton (1978), Barnes et al. (2000)
Vancouver, British Columbia, Canada	before 1978	(not stated)	Kelton (1978)
St. John's, Newfoundland, Canada	May 1977	1 ♀	Scudder (1986)
Seattle, King Co., Washington (University of Washington campus)	August 2006	19 ♀, 12 ♂	Wheeler et al. (2008)
	August 2007	1 ♀	this study
	September 2007	6 ♀, 25 ♂	
	July 2008	9 ♀, 3 ♂, 18 nymphs	
	August 2008	5 ♂, 1 nymph	

of *A. confusus* from western Washington State in 2007–2008. Herein, we summarize both the historical and new records for *A. confusus* in North America. Characters that can be used to separate *A. confusus* from other North American species of *Anthocoris* are discussed. We briefly summarize plant records for *A. confusus* in both the Old and New World. Finally, we list other species of predatory Heteroptera that we found in association with *A. confusus* at the collecting site. The samples included three additional Old World species.

Anthocoris confusus Reuter, 1884

The first North American record for this Palearctic species is by Anderson and Kelton (1963) for specimens collected in the 1920s–1940s from the Great Lakes Region of Ontario, Canada (Table 1). Additional specimens were collected by L.A. Kelton from that same area in the 1950s and 1960s. The earliest records for the United States are from 1932 for a single specimen collected in eastern New York, followed by specimens collected in 1938 at Bar Harbor, Maine (Table 1). Other U.S. records

include eight specimens collected in 1955 from Isabella County, Michigan (Lewis et al. 2005). Five specimens from western North Carolina are deposited in the museum at North Carolina State University. Included are two specimens collected in the late 1950's, and an additional three insects collected in 1995. The only published record for western North America is for a single specimen collected in 1977 at Vancouver, British Columbia, Canada (Scudder 1986). Henry (1988; with updates in Henry and Froeschner (1992)) listed *A. confusus* from British Columbia, Nova Scotia, Ontario, Prince Edward Island, Maine, and Tennessee; the catalog of Maw et al. (2000) listed the Canadian provinces from which *A. confusus* has been collected; Wheeler et al. (2008) added Newfoundland to the Canadian records.

New records.—In 2007 and 2008, we collected adults and nymphs of *A. confusus* from European beech (*Fagus sylvatica* L.; Fagaceae) and linden (*Tilia* L.; Tiliaceae) on the campus of the University of Washington, Seattle, King County, Washington: 26 August 2007 (*F. sylvatica*: 1 ♀); 13 September 2007 (*F. sylvatica*: 6 ♀, 25 ♂); 2 July 2008 (*F. sylvatica*: 1 ♂, 18 nymphs; *Tilia* sp.: 8 ♀, 2 ♂); 22 July 2008 (*F. sylvatica*: 1 ♀); 15 August 2008 (*F. sylvatica*: 2 ♂; *Tilia* sp.: 3 ♂, 1 nymph). The linden trees were heavily infested with the aphid *Eucallipterus tiliae* (L.) (Homoptera: Drepanosiphidae); it is unclear what prey were available to *A. confusus* on the beech trees, although a number of cast skins from aphids were noted. We confirmed identifications of nymphal *A. confusus* by rearing them to the adult stage on a diet of *E. tiliae*.

Identification.—Characteristics of the hemelytra are of particular value in separating North American species of *Anthocoris* (Hill 1957, Kelton 1978). The hemelytra of *Anthocoris confusus* are



Fig. 1. Clasper of male *Anthocoris confusus* collected from *F. sylvatica* on campus of University of Washington, Seattle, Washington (September 2007).

partially pruinose, separating this species from North American species whose hemelytra are entirely shiny. The dull or pruinose area of the hemelytra in *A. confusus* encompasses the entire clavus and endocorium (except for a narrow strip adjacent to the membrane), a strip along the inner embolium, and the inner angle of the cuneus. The remainder of the cuneus and the outer portion of the embolium are shiny. *Anthocoris nemoralis* (Fabricius), which may often occupy the same habitats as *A. confusus*, has a similar appearance. *Anthocoris confusus* can be separated from *A. nemoralis* by the appearance of the embolium, which in *A. nemoralis* is entirely shiny. The clasper in the male of *A. confusus* is distinct in having a sharply defined pre-apical tooth (Fig. 1). Kelton (1978) provided a key to the North American species of *Anthocoris*, which includes *A. confusus* and *A. nemoralis*. Illustrations of claspers are provided by Kelton (1978) and Péricart (1972).

Other predatory Heteroptera collected.—Predatory Heteroptera found in association with *A. confusus* on linden and European beech at the University of Washington site included three other

non-indigenous species. Adults of *A. nemoralis* were collected from both plant species: *F. sylvatica*, 13 September 2007 (2 ♀, 1 ♂); *Tilia* sp., 2 July 2008 (2 ♀, 1 ♂). This species is native to Europe but is now well-established in western North America from British Columbia south into southern California. Horton et al. (2004) provided a chronological summary of North American records for this species. Both *Fagus* and *Tilia* are known plant sources of *A. nemoralis* in Europe (Horton et al. 2004). *Anthocoris nemoralis* is an important predator of pear psyllids, *Cacopsylla* spp. (Hemiptera: Psyllidae), in pear orchards of both the Old and New World (reviewed in Horton et al. 2004).

The second Old World species, *Campyloneura virgula* (Herrich-Schaeffer) (Miridae), was collected from *Tilia* sp.: 2 July and 22 July 2008 (7 ♀). This insect was first recorded in North America from British Columbia, Canada, in 1949 (Downes 1957), and is now known to occur in Washington, Oregon, and northern California (Lattin and Stonedahl 1984). Both *Fagus* and *Tilia* are known sources of *C. virgula* in the Old World (Strawiński 1964, Lattin and Stonedahl 1984). The predator feeds on aphids, psyllids, and other soft-bodied arthropods (Lattin and Stonedahl 1984). The absence of male *C. virgula* in samples is typical (Lattin and Stonedahl 1984), as this species is parthenogenic in North America.

The third European species, *Orthotylus nassatus* (Fabricius) (Miridae), was collected from *Tilia* sp. on 22 July 2008 (1 ♀, 2 ♂, 3 nymphs) and 15 August 2008 (2 ♀). Identification was made using the key in Southwood and Leston (1959) and by examination of claspers (Southwood and Leston 1959, Henry 1977, Kelton 1982b). This bug is widely distributed in Europe on deciduous trees, including *Tilia*, *Quercus* (Fagaceae), *Fagus*, and *Alnus* (Betulaceae) (Southwood

and Leston 1959, Kelton 1982a). Species in this genus appear to be partially predaceous on aphids, mites, or other soft-bodied arthropods (Southwood and Leston 1959, Kelton 1982a). *Orthotylus nassatus* has been found in pear orchards infested with pear psylla, *Cacopsylla pyricola* (Förster) (Henry 1977, Kelton 1982a). We obtained feeding by nymphs of *O. nassatus* on immature pear psylla in laboratory assays. Both nymphs and adults also fed on pear foliage in our assays. The first North American records for this Old World species are for three specimens collected in 1973 and 1977 from three counties in Pennsylvania (Henry 1977, Henry and Wheeler 1979). Henry (1977) also provided a description of the adult male, drawings of the male genitalia, and a key to *Orthotylus* and related genera in eastern North America. Additional North American records were listed in Kelton (1982a), Wheeler and Henry (1992), and Barnes et al. (2000): Ontario (1963), Nova Scotia (1966 and 1976), and Prince Edward Island (1976), Canada; and Washington, D.C. (1986). Our records are the first for this species in western North America.

Finally, a native mirid, *Deraeocoris fasciolus* Knight, was collected from both *F. sylvatica* and *Tilia* sp. at the University of Washington site. This predatory species is widespread throughout Canada and the northern United States, and may be collected from a variety of deciduous tree species (Kelton 1982b, Razafimahatratra 1981).

Voucher specimens.—Voucher specimens of the two species of *Anthocoris* and the three species of Miridae are deposited with the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

DISCUSSION

Faunal lists have shown that the Anthocoridae in any particular geographic region may include a mix of

native and introduced species (e.g., Scudder and Foottit 2006; Lattin 2007a, b, c). In some regions, the numbers of non-native species of Anthocoridae may approach or exceed the numbers of native anthocorids, as shown in recent faunal lists for Hawaii and the Galapagos Islands (Lattin 2007a, Lattin 2007b). Some introduced species were found to be quite widespread geographically in the region of introduction at the time of discovery (e.g., Henry et al. 2008), which may be evidence of a relatively long presence in the new region. Introductions of some Anthocoridae are known to have been intentional as part of classical biological control efforts (Davis and Krauss 1963, Horton et al. 2004, Lattin 2007b), although it is not always clear whether establishment of the introduced species in a new geographic region was indeed due to the release or was instead the consequence of an accidental introduction either before or after the intentional release (Brenner and Lattin 2001, Horton et al. 2004).

Records for *A. confusus* in North America are widely distributed, both temporally and geographically (Table 1). This pattern suggests that there have been multiple introductions of this species into North America, although it is conceivable that the widely dispersed records for this species are in part due to range expansion associated with human transport (Scudder and Foottit 2006). The sources of the *A. confusus* introductions are not known, although Kelton (1978) suggested that the species may have entered the Great Lakes Region of Canada in association with imported nursery stock. Records for *A. confusus* in western North America are limited to the coastal areas (Table 1). This apparently localized distribution suggests that the insect may have entered western North America on imported goods brought in through northwestern ports.

Anthocoris confusus is generally found on deciduous trees, and in its native range appears to have preferences for beech (Anderson 1962; Hill 1965, 1978; Taksdal 1965; Péricart 1972; Štepanovičová and Lapková 1988; Floren and Gogala 2002; Goßner 2006), oak (*Quercus*) (Southwood and Leston 1959; Anderson 1962; Hill 1965, 1978; Taksdal 1965; Péricart 1972; Goßner 2006), and linden (Anderson 1962, Taksdal 1965, Péricart 1972). Other plant records for *A. confusus* in the Palearctic Region include: *Ulmus* (Ulmaceae) (Urban 2003), *Platanus* (Platanaceae) and *Salix* (Salicaceae) (Anderson 1962), *Betula* (Betulaceae), *Sorbus* (Rosaceae), and *Crataegus* (Rosaceae) (Hill 1965, 1978), *Laurus* (Lauraceae) and *Populus* (Salicaceae) (Péricart and Halperin 1989), and *Acer* (Aceraceae) (Péricart 1972). Records for *A. confusus* in Canada include most commonly *Fagus* (Anderson and Kelton 1963, Kelton 1978, Wheeler et al. 2008), with additional specimens having been collected from *Acer*, *Rosa* (Rosaceae), *Tilia*, and *Quercus* (Kelton 1978, Wheeler et al. 2008). Thus, the North American records include to a large extent plant genera (i.e., *Fagus*, *Tilia*, *Acer*, and *Quercus*) known to be of importance to *A. confusus* in Europe.

In summary, samples of Heteroptera collected from European beech and linden on the campus of the University of Washington included the Old World true bug *A. confusus*, a species collected only very irregularly in North America beginning in the late 1920's. Our collections from the University of Washington campus in 2007–2008 included both adults and nymphs, and are the first records for this species in the western United States. The occurrence of nymphs in our samples, combined with the fact that the species was present in the same stand of trees in two consecutive years, suggests that *A. confusus* is established at the collecting site on the campus

grounds. Wheeler (2008) observed that university campuses in otherwise urban centers may provide islands of habitat for insects and other fauna not found in the surrounding urban areas, providing opportunities for studies of biodiversity not otherwise available in that location. These studies have often resulted in the discovery of immigrant species not previously known to be present in the region (Wheeler 2008), and the occurrence of *A. confusus* and *O. nassatus* in our samples appear to be additional examples of this phenomenon. We suggest, however, that these non-native species probably are more widespread in the Seattle area than is indicated by our limited sampling efforts made on the University of Washington campus. Both linden and beech have been planted extensively along the streets of Seattle (Clark and Jacobson 2001), and it seems likely that sampling of these tree-lined areas would lead to additional records for both *A. confusus* and *O. nassatus* in the Seattle region.

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